

PREFERENCE MAPPING OF SLOVAK CHEESE

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ABSTRACT

The production of steamed cheese has a long tradition in Slovakia. Some of these cheeses have even received the PGI designation, which is a designation granted to products with specific geographical characteristics (Slovenská parenica, Zázrivské vojky, Zázrivský korbáčik, and Oravský korbáčik). In our study, eight samples of various unsmoked steamed cheese from small dairy farms (samples D, F, G, and H) and medium-sized farms (A, B, C, and E) were evaluated. Our work aimed to determine whether there are significant differences in sensory characteristics between samples from small and medium-sized dairy farms and whether there are differences in the preferences between these samples for consumers. Samples were evaluated by sensory analysis, where the assessors evaluated the characteristics of color, odor, texture, flavor, and overall appearance on a nine-point hedonic scale. Differences at a statistically significant level in the attributes of odor, texture, flavor, and overall appearance were confirmed ($p < 0.05$) between samples from small and medium dairy farms, no statistically significant difference was proved in the attribute color ($p > 0.05$). The results were processed using PCA, whereas can be seen from the graphic representation the carriers of all evaluated attributes were samples from medium-sized farms (except for sample D, which belonged to the first group of samples together with samples from medium-sized farms). We constructed a preferential map by combining internal and external mapping, while the internal data were formed by data obtained from assessors using sensory analysis and the external data came from an online questionnaire. Using the preferential mapping technique, we found out that samples from medium-sized dairy farms were classified as the most preferred samples which correspond with the results of sensory analysis.

Keywords: steamed cheese; unsmoked; preference mapping; sensory analysis

INTRODUCTION

Cheese production is one of the traditional ways of food preservation. Preservation of fats and proteins as the most important components of milk in the form of cheese uses two principles of food preservation: lactic acid fermentation and water activity reduction by removing water and adding NaCl (Fox et al., 2004). There are more than 1000 types of cheese in the world, which differ from each other in sensory and chemical characteristics (Montel et al., 2014).

Production of steamed cheese has a long tradition not only in Slovakia but also in eastern Europe and Balkan countries. This type of cheese is according to Čubon et al. (2015) called Pasta filata. Traditional Slovak steamed cheese can be found in many different shapes and sizes, smoked or unsmoked, made from pasteurized or unpasteurized milk, bovine, ovine or mixed origin, etc. Characteristic shapes are strings (Zázrivské vojky), little whips (Zázrivský korbáčik, Oravský korbáčik), and most traditional „S“ shape (Slovenská parenica) (Tasteatlas, 2020). Zázrivské vojky (Commission Regulation (EU) no 963/2014), Zázrivský korbáčik (Commission Regulation

(EU) no 238/2011), Oravský korbáčik (Commission Regulation (EU) no 243/2011), and Slovenská parenica (Commission Regulation (EC) no 656/2008) are included in the PGI and PDO list of the European Union. According to Council Regulation (EC), no 510/2006 traditional Slovak parenica cheese is described as steamed cheese that can be unsmoked or smoked, traditionally manufactured and shaped in „S“ shape.

In recent years there have been several food scandals that decreased consumers' trust in food safety (Kozelová et al., 2013). Consumers' demands for food with high-quality are still growing (Rana and Paul, 2017). For the last few years, there has been increasing attention towards food quality and food safety and also growing demand for „natural“ products (mostly those with PGI, PDO, and TSG designation) (Todaro et al., 2017).

From the point of view of human nutrition, as well as from the economic point of view, the dairy industry belongs to the main branches of the food industry in the Slovak Republic. In line with the global trend, the consumption of cheese and curds has increased, with consumers preferring natural cheese over processed

cheese. The largest volume of the total value of foreign trade in the dairy industry consists of cheese and cottage cheese. The export of Slovak cheese is mainly focused on the EU-28 market (Gálik, 2019).

Consumption of milk and dairy products without butter in 2018 was 171.1 kg, which was less by 3.5 kg (2.0%) compared to the year 2017. The decrease in consumption was mainly reflected in sour milk products by 0.6 kg (3.4%) and cheese and curds together by 0.2 kg (1.5%). Because milk and dairy products are the main sources of calcium and protein, their low consumption is nutritionally unfavorable. In 2017, according to available data from Central European countries, for example, the Czech Republic (239.3 L) and Poland (218 L) had a high consumption of dairy milk in the value of butter-free milk per capita. In the Slovak Republic, the consumption of milk was 169.5 L per capita. Hungary had a comparable value of consumption as in Slovakia in 2017 with 160.7 L per capita. The total consumption of cheese and curd in 2018 was 13.3 kg per capita in the Slovak Republic, in 2017 it was 13.5 kg (ŠÚSR, 2019).

Preference mapping is a methodology that helps us to identify the sensory attributes which are the main drivers of liking and the most preferred products for different consumer groups. This technique uses multivariate tools to create bidimensional plots (maps) that link product characteristics and consumer preferences (Berget et al., 2020). Preference mapping has become a standard tool not only in sensory studies of food but also in other product categories (Mattila, 2001; Zacharov and Koivuniemi, 2001). For performing preference mapping liking/preference data obtained from consumers and a descriptive sensory profile for the same products is needed. Firstly, PCA (Principal Component Analysis) is used on the independent data, then the dimension reduction techniques are applied depending on the data. There are conceptually two different ways of performing preference mapping – internal and external. In internal preference mapping, the sensory data is modeled from the consumer data and in external preference mapping the order is switched, so consumer preferences are predicted from sensory data (Berget et al., 2020). Both internal and external approaches have their pros and cons (Næs, Varela, and Berget, 2018).

Our work aimed to find out the preferences of consumers of unsmoked steamed cheese from small and medium-sized producers and confirmation that there are differences in sensory characteristics between cheese from medium-sized and small farms.

Scientific hypothesis

Hypothesis 1: There exist significant differences in sensory attributes between unsmoked steamed cheese from small and medium-sized producers.

Hypothesis 2: There exist differences in preferences between unsmoked steamed cheese from small and medium-sized producers.

MATERIAL AND METHODOLOGY

Samples

8 samples of unsmoked steamed cheese (nite and parenica) were obtained directly from medium-sized

producers and small farms on the day of production. Samples A, B, C, and E (4 samples) were produced by medium-sized producers, and samples D, F, G, and H (4 samples) were manufactured in small farms. All of the samples of unsmoked steamed cheese can be seen in Figure 1.

Sensory analysis

The sensory evaluation was performed in a sensory laboratory designed according to ISO 8589:2007 located in the Slovak University of Agriculture in Nitra. Samples were coded with 3-digit number codes and served on white ceramic plates at temperature 20 ± 2 °C. Samples for evaluation were prepared by cutting the cheese into smaller portions. Samples were evaluated the day after production. 10 assessors who were all students and employees of the Slovak University of Agriculture in Nitra took part in this evaluation. All of them had previous experiences with a sensory evaluation of dairy products.

A nine-point hedonic scale was used for sensory evaluation, where 1 was very bad and 9 was very good. Evaluated attributes were color, odor, texture, flavor, and overall appearance. Williams Latin square design was used for sample randomization (Williams, 1949; Wang, Wang, and Gong, 2009). Mineral water was used as a palate cleanser to neutralize the taste between samples.

Preference mapping

Internal mapping data were obtained from the sensory analysis of samples. Data needed for external mapping were collected from an online questionnaire with 120 responses. Respondents were asked to score the samples according to their personal preferences on a nine-point scale.

Statistical analysis

For analysis of sensory data was used Shapiro-Wilk normality test and parametric t-test (RStudio software, version 1.3.1093, R Foundation for Statistical Computing, Vienna, Austria). Data analysis for PCA and Preference mapping was carried out with XLSTAT statistical software (version 2020.5.1 by Addinsoft). Internal data from the sensory evaluation were processed with PCA (Principal Component Analysis) and external data from the online questionnaire were used for AHC (Agglomerative Hierarchical Clustering).

RESULTS AND DISCUSSION

Slovenská parenica, Oravský korbáčik, Zázrivský korbáčik, and Zázrivské vojky granted the PGI designation (Protected Geographical Indication) in 2008 – 2014. Regarding the PDO, PGI, and TSG labels there have been reported numerous problems. Food adulteration has many forms e.g. substitution, mislabelling, masking of origin, decreasing quality of food products, intentional misinterpretation, artificial enhancement, etc. (Fikselová et al., 2020). According to Singh and Gandhi (2015), milk and milk products are typically adulterated with the use of preservatives and adulterants (benzoic acid, water addition, hydrogen peroxide, salicylic acid, etc.).



Figure 1 Samples (A – H) of unsmoked steamed cheeses.

Table 1 Summary table of sensory analysis.

Sample	Colour		Odour		Texture		Flavour		Overall appearance	
	Average	Variance	Average	Variance	Average	Variance	Average	Variance	Average	Variance
A	7.00	2.00	7.00	2.96	7.00	3.16	7.00	3.49	7.00	2.01
B	6.00	2.81	6.00	4.00	8.00	2.00	6.00	2.44	7.00	1.96
C	6.00	3.29	7.00	2.00	7.00	4.00	6.00	3.25	7.00	2.24
D	6.00	3.58	7.00	2.00	7.00	2.00	6.00	5.01	7.00	4.44
E	7.00	1.96	6.00	4.00	7.00	4.00	6.00	4.01	7.00	1.69
F	6.00	2.49	5.00	4.00	7.00	1.00	4.00	2.89	5.00	3.80
G	5.00	5.44	4.00	2.00	7.00	1.00	3.00	3.21	4.00	4.84
H	6.00	3.85	5.00	6.00	6.00	5.00	6.00	3.76	6.00	2.81
<i>p</i> -value	0.1857		0.00111		0.04885		0.01456		0.02449	

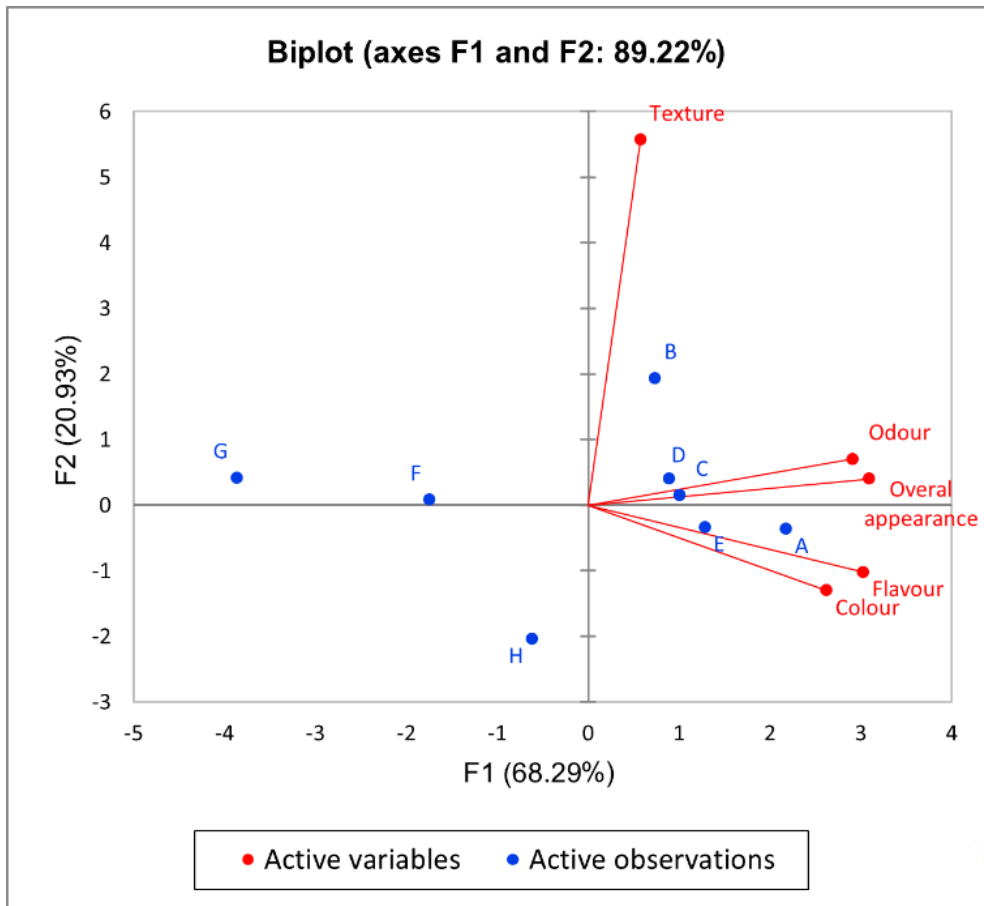


Figure 2 PCA map of samples.

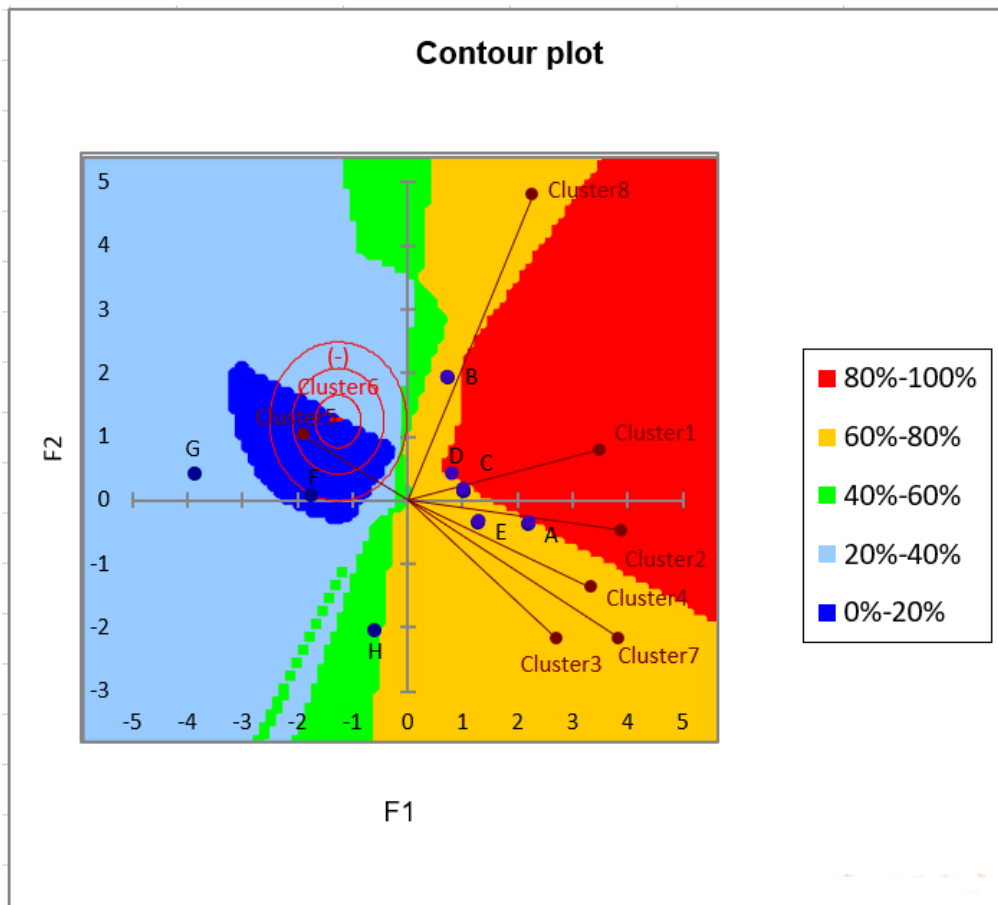


Figure 3 Visualization of the consumers preferences with preference map.

Characteristic steamed cheese production and starter cultures are mentioned in the work of **Onipchenko et al. (2012)**, **Štefániková et al. (2019)**, and **Zimanová et al. (2016)**.

The summary of sensory analysis results is presented in Table 1. There was no significant difference between samples from medium-sized and small farms in the parameter color ($p > 0.05$). Statistically significant differences were detected in the attributes odor, texture, flavor, and overall appearance ($p < 0.05$), where samples with higher consumer acceptance were evaluated samples from medium-sized farms in all parameters (Table 1). Authors **Semjon et al. (2019)** detected differences between experimental parenica cheese samples in every evaluated sensory parameter in the early stage of storage. They also observed statistically significant differences ($p < 0.05$) between samples in sensory parameters after storage. Similar sensory attributes and a nine-point scale were used by authors **Tauferova et al. (2014)** in their study of the sensory texture of ketchup.

PCA map of evaluated unsmoked steamed cheese samples can be seen in Figure 2. Samples were divided into two groups, the first group consisted of samples from medium-sized farms (A, B, C, E) and one sample from the small farm (D), the second group consisted of three samples of cheese from small farms (F, G, H). All of the evaluated parameters were characteristic for the first group of samples. Sample B had the highest rating in texture parameters. Samples A, C, D, and E obtained high values in the evaluation of odor, overall appearance, flavor, and color. On the other hand, there were samples from the second group (F, G, H) where sample H had the worst texture, it was very solid and firm. Samples in the second group also lacked odor, flavor, color, and overall appearance attributes.

The preference map of evaluated unsmoked cheese can be seen in Figure 3. In the highest consumer preference zone (80 – 100%) were partly located samples A, C, and D, these samples were also located in the second preference zone of 60 – 80%. These samples were preferred the most by the respondents. Samples B and E were located in the zone of preference 80 – 60% and sample H can be seen in the green field with preference 40 – 60%. As less preferred sample consumers chose sample G (20 – 40%) and the least preferred sample was sample F (0 – 20%). The preference map corresponded with the results of sensory analysis and samples obtained from medium-sized farms had higher preferences from consumers than samples coming from small farms. Preference mapping was previously used in the analysis of a wide variety of foodstuffs e.g. ham (**Benešová et al., 2019**), parenica steamed cheese (**Semjon et al., 2019**), raw garlic (**Drdolová, Martišová and Benešová, 2019**), fresh fruit (**Villamor et al., 2013; Jaeger et al., 1998; Lado et al., 2010**), vegetable (**Sinesio et al., 2010**), etc.

In a similar study authors **Drdolová, Martišová and Benešová (2019)** evaluated 10 varieties of winter garlic using PCA and preference mapping techniques. According to their findings, assessors tend to overestimate samples with attractive appearance and to focus on textural parameters of samples.

According to **Zajác et al. (2019)** quality of a traditional product can vary from farm to farm. It is mainly caused by

differences in cheese-making technology e.g. temperature of milk pasteurization, type, and a dose of rennet, amount of salt, smoking, drying process, etc. In their work, **Zajác et al. (2019)** studied differences in textural and sensory characteristics of typical Slovak cheese – oštiepok. They confirmed significant differences ($p < 0.05$) between the samples from different regions in both textural and sensory attributes.

The different temperature used during cheese maturation affects the content of the microorganisms (**Kunová et al., 2015**). Microbial count increases when using insufficient pasteurization and there is a possibility of cross-contamination (**Zajác et al., 2019**).

Authors **Ducková et al. (2019)** in their work studied the effect of somatic cell count (SCC) in milk intended for parenica cheese making. They compared the number of somatic cells in milk from small dairy farms with milk from industrial companies and they did not find the statistically significant difference ($p > 0.05$). However lower SCC was observed in samples from industrial dairies. According to **Hachana, Znaidi and M'Hamdi (2018)** higher values of SCC can have a negative effect on dairy products shelf life and sensory characteristics.

CONCLUSION

In our study, we proved the existence of differences in sensory attributes between samples manufactured in small dairy farms and samples from medium-sized industry farms. The differences at the statistically significant level ($p < 0.05$) were detected in the parameters odor, texture, flavor, and overall appearance. From the map of principal component analysis can be seen that samples from industry farms obtained high values in the evaluation of all sensory attributes and samples from small dairy farms (except sample D) lacked in these parameters. The results obtained from preference mapping also coincided with the above mention analyses and therefore the most preferred samples came from medium-sized industry farms.

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- Commission Regulation (EC) No 656/2008 registering certain names in the Register of protected designations of

- origin and protected geographical indications (*Chamomilla Bohemica* (PDO), *Vlaams-Brabantse tafeldruif* (PDO), *Slovenská parenica* (PGI), *Cipollotto Nocerino* (PDO)).
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